Combined Non-Conventional Instrument Transformer CNCIT-145

User's Manual

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This manual is a part of the complete set of product documentation. Users should evaluate the information in the context of the complete set of product documentation.

Profotech assumes no liability for any incidental, indirect or consequential damages arising from the use of this documentation.

While all the information presented is believed to be reliable and in accordance with accepted engineering practices, Profotech makes no warranties regarding to the completeness of the information (text and drawings) of this document.

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Preface

In these manual detailed instructions for operation and maintenance of CNCIT are presented.

The complete documentation set includes the following documents:

- CNCIT Technical Passport
- CNCIT User's Manual

Safety precautions

- Use the transformer only for its intended purpose.
- Never put the transformer into operation if it's damaged.
- The installation should be carried out only by Profotech or Condis personnel.
- All personnel involved in installation, operation and maintenance must have experience and the necessary knowledge in dealing with high voltage equipment.
- Follow the technical data given on the rating plate and in the specification.
- National and local electrical safety regulations must be followed.

Warning! All parts of CNCIT must be properly grounded, regardless of the operating conditions (including special occasions such as testing, demonstration, configuration and maintenance).

Customer Support

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1 Product description

1.1 General

CNCIT is a high-accuracy combined current and voltage transformer that generates an output signal according to IEC 61850-9-2 standard.

1.2 Technical specifications

Technical specifications of the supplied CNCIT are presented in the CNCIT Technical Passport (refer to the product documentation set).

1.3 Operating principle

The current measurement principle of CNCIT is based on the *Faraday effect* (Figure 1). Two light waves with orthogonal circular polarization propagate through the sensitive fiber coil located inside the SE. If current flows through the conductor inside the coil, the optical fiber appears in the magnetic field generated by the current. This magnetic field alters the optical properties of the fiber, causing a relative phase shift between the propagating waves. The phase shift is directly proportional to the measured current's magnitude and the number of turns in the sensitive fiber.

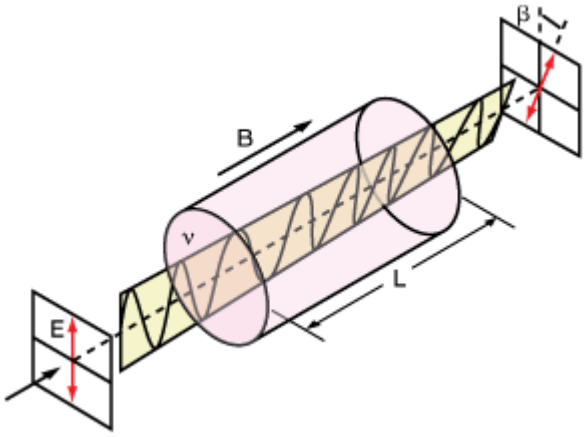


Figure 1 – Faraday effect

The phase shift is accurately measured using the low-coherence interferometry technique and then converted to digital form by optoelectronic circuit located in ECT EPU.

Inside the SE case, there can be up to three multi-turn sensitive loops inside SE case that are able to cover the full accuracy range required by the customer’s needs.

The principle of voltage measurement is based on conversion of the high voltage to lower values using a capacitive divider. Converted voltage values are then measured and digitized by a special measuring module placed at the bottom of the HV column and connected to the midpoint of capacitive divider.

The connection between the measuring unit and the EVT EPU is made through a hybrid (fiber/copper) cable. The measured values data, reference frequencies of the synchronized measurements and parameters of the self-diagnostics are transmitted via optical fiber in digital format. Galvanic isolation in the power supply circuit is achieved using several transformers (refer to Figure 2).

CNCIT comprises at least two EPUs devices: one for current measurement (ECT EPU) and one for voltage measurement (EVT EPU).

If relay protection functions for current measurements are necessary, the CNCIT can be equipped with one or two ECT EPUs connected to separate sensing coils placed at the same SE housing.

In case of redundancy demand for voltage measuring, a second EVT EPU with separate measuring modules for each phase can be installed.

1.4 ECT EPU

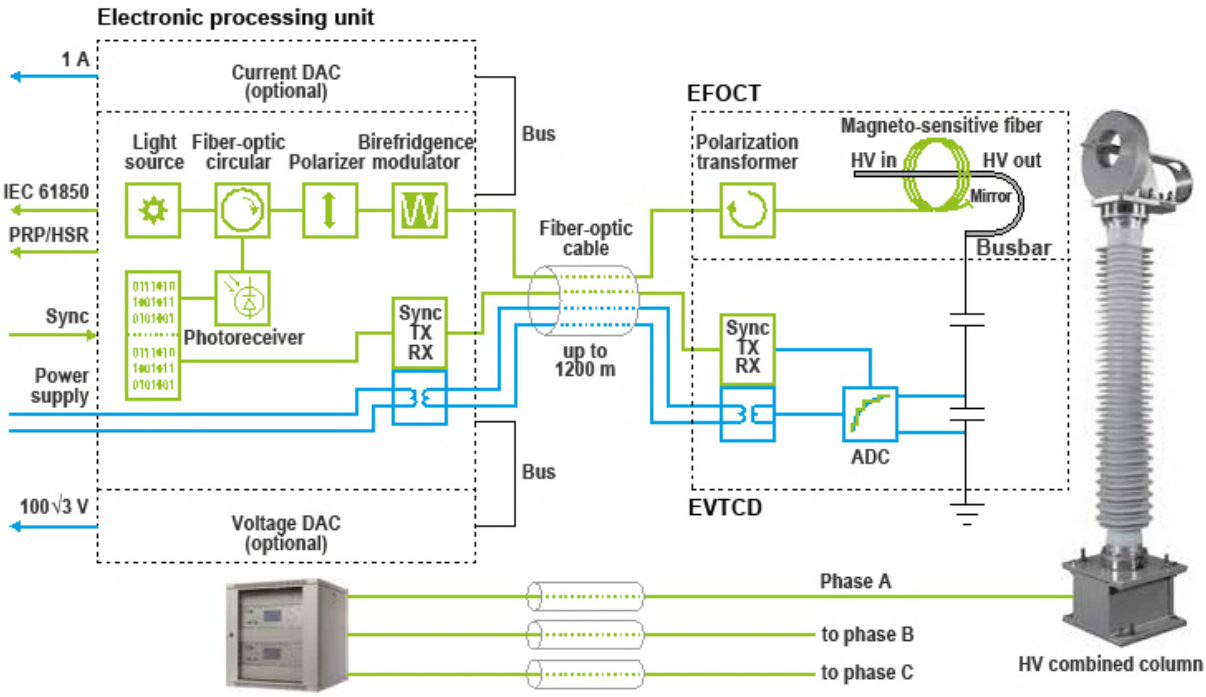


Figure 2 – General schematic of the CNCIT

The ECT EPU measures and processes optical signals acquired from the sensing elements. Based on the measured optical signal, the DSP of the EPU calculates the effective current value.

EPU is manufactured in a 19" (483 mm) aluminum housing, allowing for installation inside a standard 19" rack. Fiber distribution units are installed above the EPU's housing (either one or two, depending on the EPU's configuration).

The appearance of the ECT EPU is shown in Figure 3.

Figure 3 – ECT EPU general view

Opening or removing fiber distribution units and EPU modules is strictly prohibited!

Fiber distribution units are connected using armored fiber optic cables with EPU optical modules.

The following elements are located on the front panel of the ECT EPU:

- display;
- LED indicators;
- navigation buttons;
- two DB-9 connectors ("Service", "Diagnostics").

External connection diagram of ECT EPU is shown in Appendix A.

The CT EPU features a modular structure, typically comprising optical modules (one per each phase), a temperature module, an interface module and a 61850 module. Modules can be installed and removed from the rear side of the Device. The front panel of the power supply module, along with power cables, is also located on the rear side, with the configuration of the power supply module dependent on the customer's technical requirements. Figure 4 illustrates the rear side of ECT EPU.

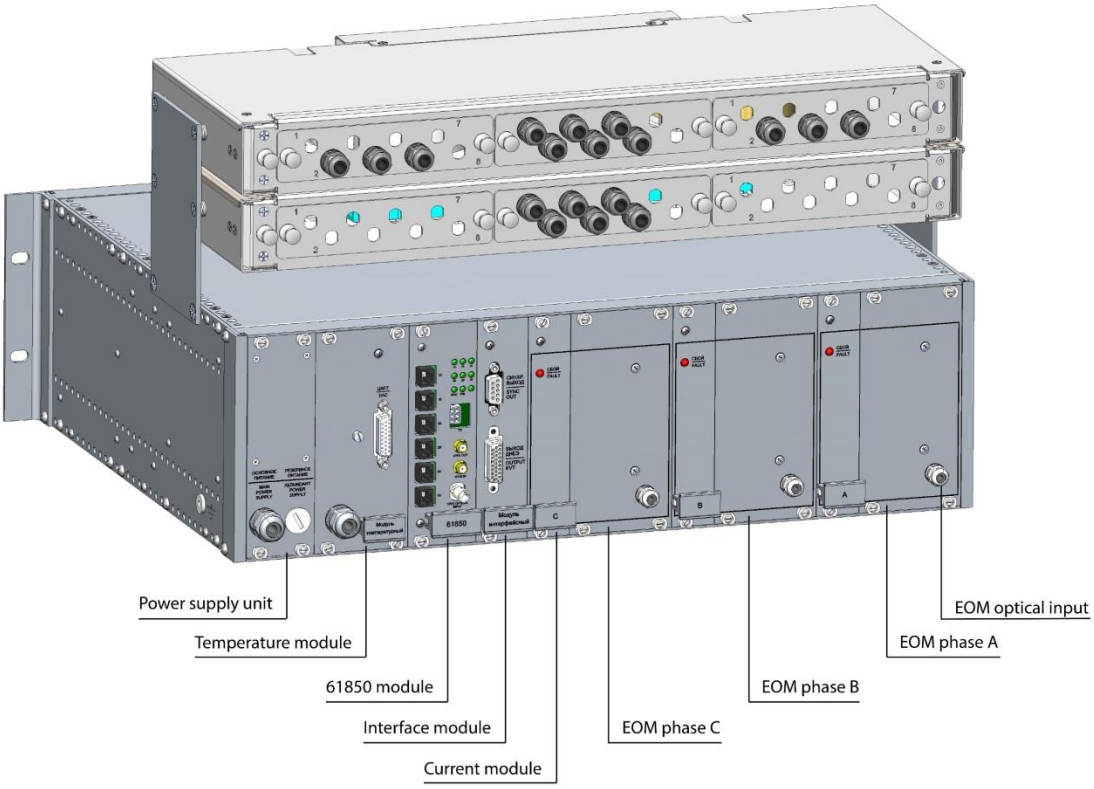


Figure 4 – The rear side of the ECT EPU

1.5 EVT EPU

The appearance of the EVT EPU is shown in Figure 5.

Figure 5 – 3-phase EVT EPU

The front panel of the EVT EPU features the following elements:

- Display;
- LED indicators;
- Navigation buttons;
- Two DB-9 connectors ('Service' and 'Diagnostics').

The EPU case is made of aluminum and designed for installation in a standard 19" rack or a cabinet with two-way maintenance access..

The EVT EPU carries out the measurement and processing of optical signals coming from three (phases A, B, C) measuring units. The unit is of modular design and includes a three-phase optical module, a voltage module, an interface module for communicating with the current ECT EPU, and an IEC 61850 module from which the data are transmitted in a digital format (IEC 61850-9-2) through the optical 100 Base-FX port to secondary measuring and protection devices. These data contain the information about instant EPU voltage values, as well as timestamps and flags characterizing the reliability of the transmitted information.

Modules can be inserted or removed from the rear side of the EPU, as depicted in Figure 6, illustrating the rear side of the voltage EPU.

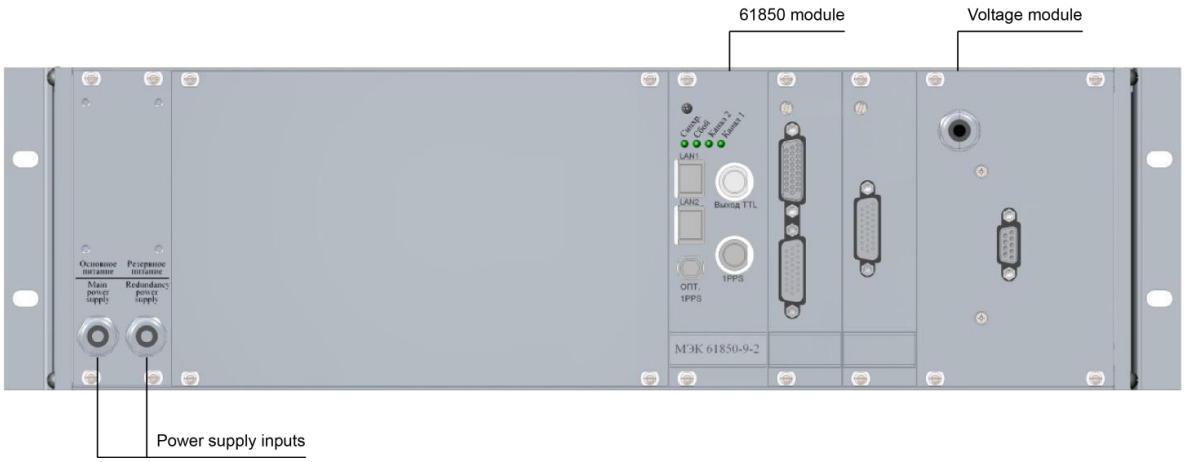


Figure 6 – Rear side of the voltage EPU without FODU module

1.6 HV Column

The HV column consists of a capacitive divider and fiber-optical Sensing Element mounted on top. Measuring units, ranging from one to two based on technical requirements, are situated in the basement of the HV column.

Figure 7 – CNCIT HV Column

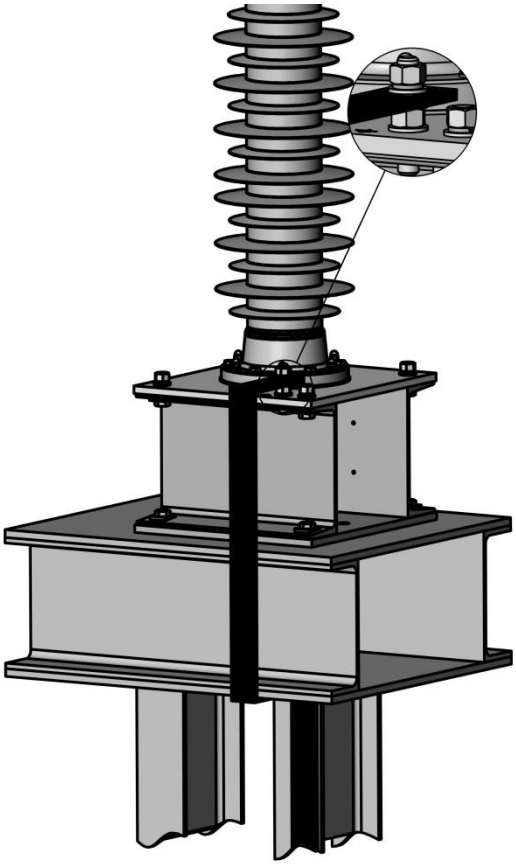


Figure 8 – HV Column grounding

HV column slinging scheme is presented on Figure 9.

Applying any loads to the SE head during column handling is strictly prohibited!

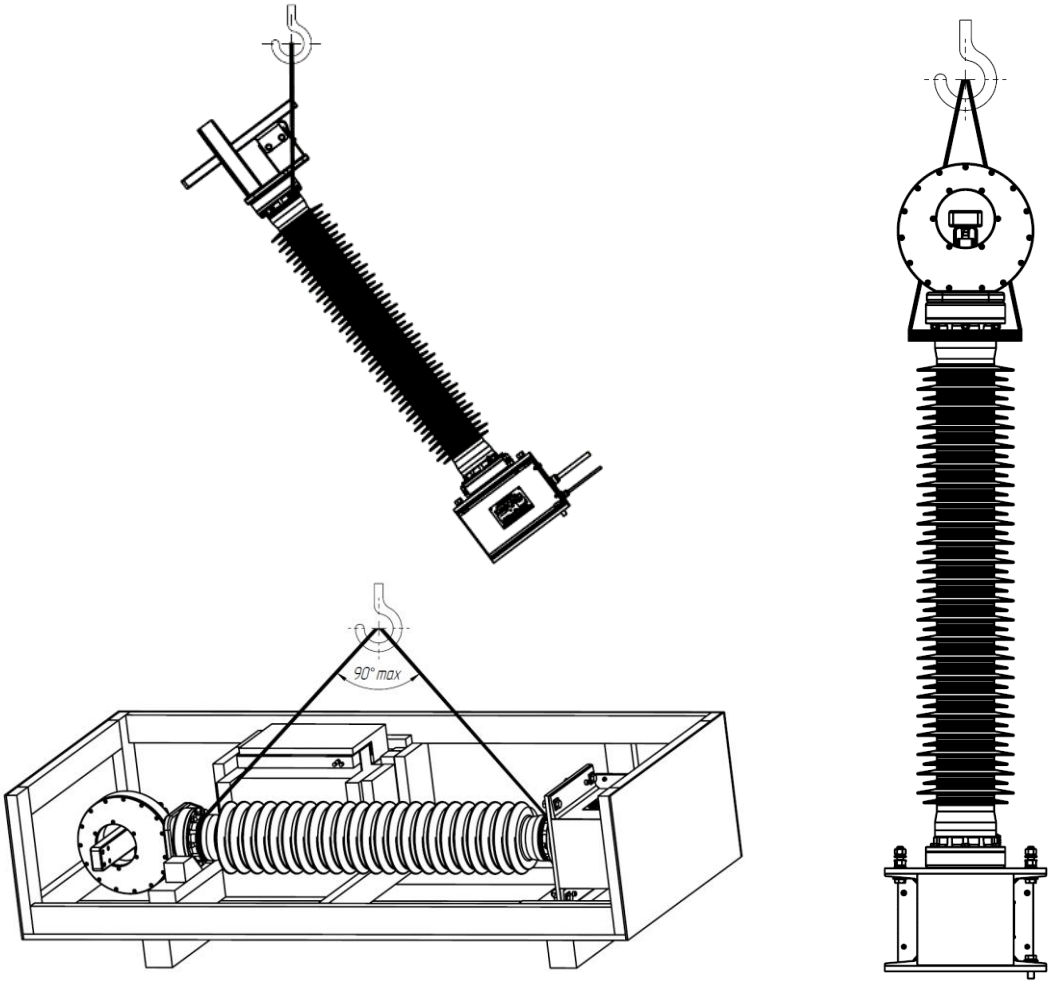


Figure 9. CNCIT HV Column slinging scheme

1.7 Marking and sealing

CNCIT	-A	-B	-C	-D	-E	-F	-G
Rated voltage, kV							
Rated current, A							
Accuracy class of voltage measuring							
Accuracy class of current measuring							
SE operating temperature range							
Special temperature range, specified in the Device's passport					S		
For indoor installation (from -10 to +40 °C)					P		
Transformer outputs, a combination of symbols							
Analog, proportional to the current of 1 A						T	
Analog, proportional to the voltage of 100/√3 V						N	
Digital outputs according to IEC 61850-9-2 with 4000 and 12800 samples per second (80 and 256 samples per power frequency period). Optionally, the sampling frequency can be changed to one of the following values: 1000, 2000, 16000, 32000, 64000 samples per second						M	
Type of power supply module							
One universal input of 220 V DC or V AC							1
Two inputs of 220 V AC or V DC							2
Redundant power supply unit							V

Designation example is shown in Figure 10.

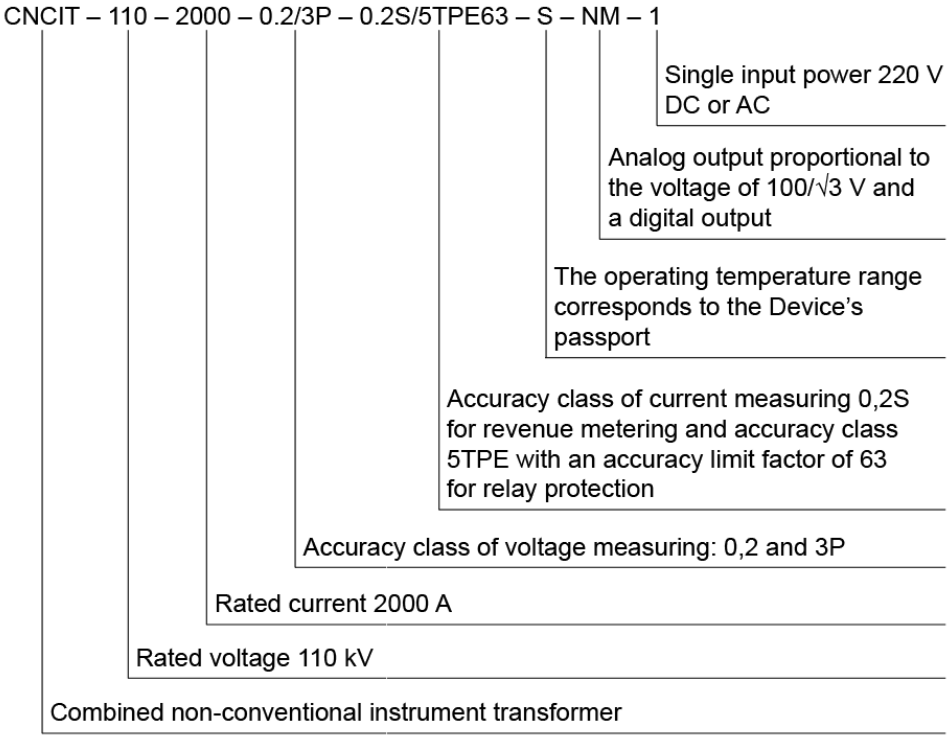


Figure 10 – Type code

There is a rating plate fixed to the flank of each EPU with the indication of the following items:

- trademark or the name of the Manufacturer;
- product name;
- type of the transformer and climatic design;
- serial number according to the numbering system of the Manufacturer;
- date (month, year) of manufacture;
- rated voltage, kV;
- rated current, A;
- accuracy class;
- output interfaces;
- CNCIT technical regulation number.

The transportation packaging contains the following labels and inscriptions:

- information about the Manufacturer;
- serial number;
- gross weight and dimensions of the packaged components of the CNCIT;
- labels with the handling marks ("Top", "Caution", "Keep away from moisture", "Fragile", "Maximum vertical load on the container").

The "Service" connector of the EPU is closed with a sealing lid.

Locations of warranty seals are shown in Figure 11.

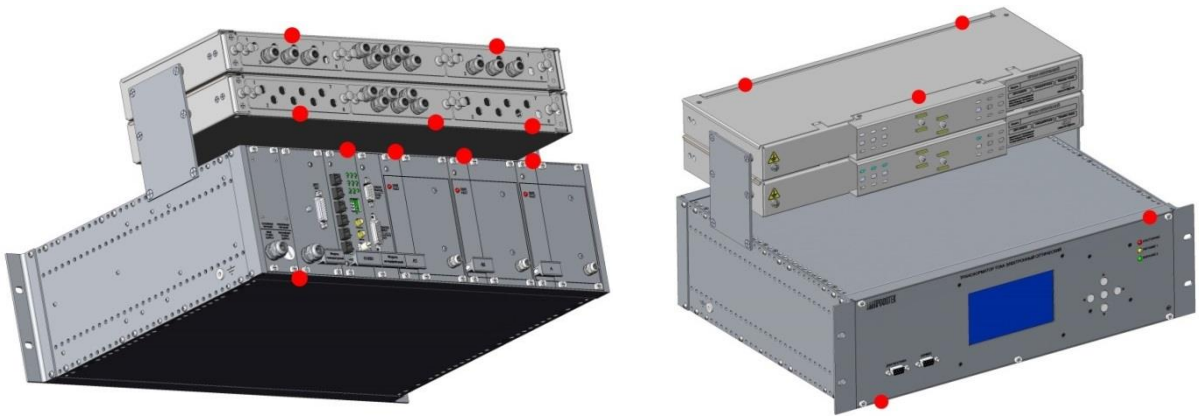


Figure 11 – Warranty seal location

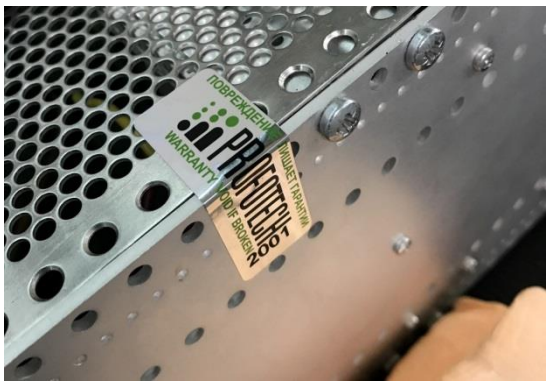


Figure 12 – Example of the product sealing

Breaking the seals will void the warranty and make any repairs non-warranty

1.8 Packaging

EPUs and HV column come assembled in a package like the one shown in Figure 13. The container walls on the inside are covered with foam plates that fix the EPU to prevent mechanical damage during the transportation. The products are covered with polyethylene film to protect them against accidental moisture penetration. The overall dimensions of the packaging are 2293×1013×620 mm.

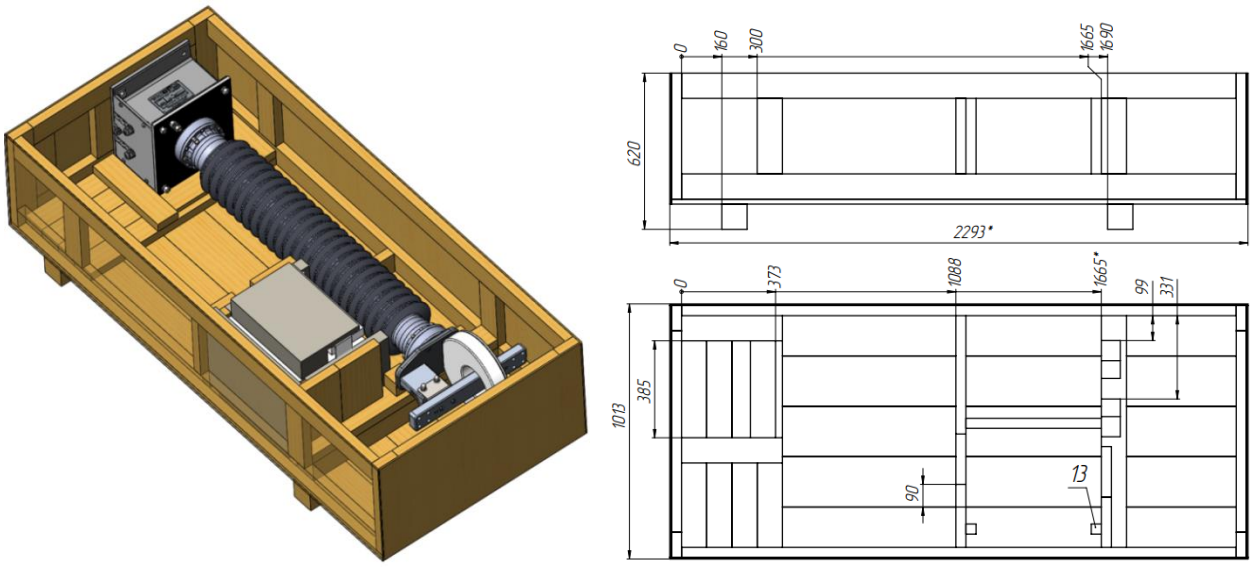


Figure 13 – CNCIT packaging

2 Device operation

2.1 ECT EPU menu

Control and adjustment of the Device are carried out via the EPU menu, which can be navigated using five control buttons. The function of each button is illustrated in Figure 14.

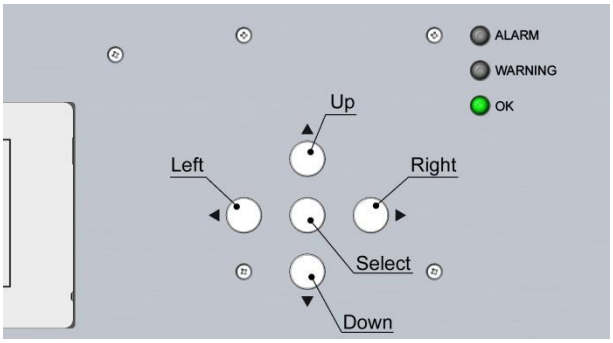


Figure 14 – Control buttons and LEDs for the Device status indication

EPU control board periodically (full cycle of data exchange is carried out twice per second) interrogates the DSP board, receiving values of current, harmonics, light source, modulator, power supply converters, EPU board temperature from the DSP board. Values of the above-stated parameters are output to the display. On the Device's front panel three diagnostic LEDs are located that reflect current EPU operating state.

If the parameters are within the permissible limits, the green LED ("Operation") is lit. If at least one of the parameters approaches the permissible boundary, the yellow LED ("Service") is lit. If at least one of the parameters is out of the permissible range, the red LED ("Fault") is lit.

The diagnosis connector is led to the front panel of EPU from the control board. Using this connector, it is possible to carry out monitoring of the parameters that determine current EPU operation, to display these parameters on the PC using the special utility and to save them as a timeline (using the special SW that is supplied upon Customer’s request).

When the unit gets energized, the necessary configuration parameters and the processing program are loaded into the DSP board from the non-volatile memory. The display screen is lit up. By default, the display picture is similar to the one shown in Figure 15. The main menu is located on the left side of the screen; on the right side

there is the RMS value of the measured current for each of the three phases. Number of the depicted phases depends on configuration setting.

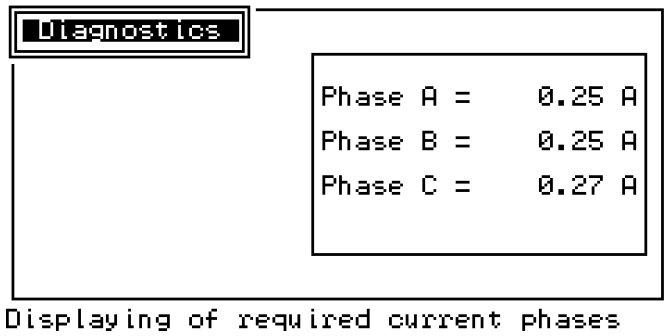


Figure 15 – Default menu view after switching on the EPU power

The User can enter the submenus without interrupting the operation of the Device. The right part of the display keeps showing actual phase current values unless a new desired parameter is selected. If the User selects the "Diagnostics" submenu, the display shows a picture similar to the one shown in Figure 16.

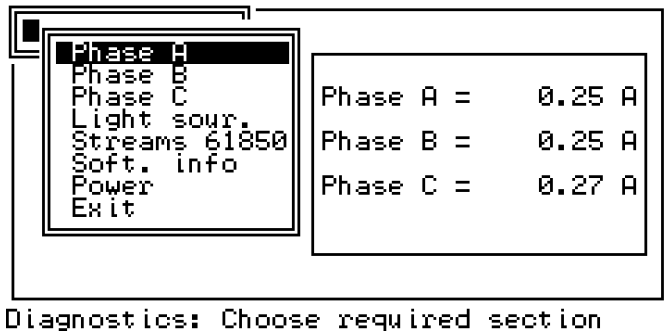


Figure 16 – "Diagnostics" submenu

The status of the optical modules for each of the three phases is monitored in this submenu, as well as the status of the light source operability. When the LED indicators on the front panel are turned on, this submenu allows the User to localize a specific fault without connecting an external PC. If any of the phases are selected in the "Diagnostics" submenu, the display screen should look similar to Figure 17.

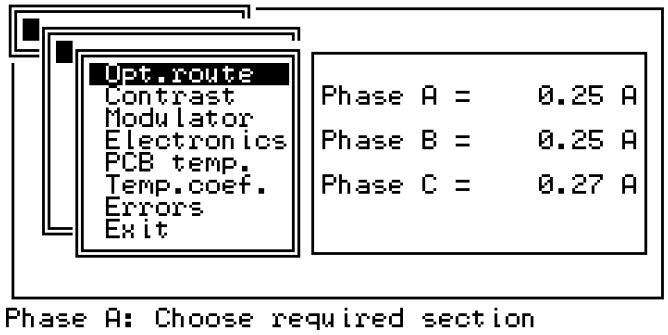


Figure 17 – "Diagnostics – Phase A"

A list of the main parameters determining the operability of the corresponding module appears on the display. These parameter values are the criteria of the working condition of the Device's modules. Moving through the lines of the submenus, the User can see the status of the key parameter of a particular module, as well as its limits when the Device is operating normally. The actual values of the components (harmonics) of the output optical signal of the interferometer which are used for calculation of the measured electric current are shown in Figure 18. They characterize the statuses of the optical path and the input electronic channel. After pressing the central button, the User can see the acceptable limits of the parameters in normal operating mode.

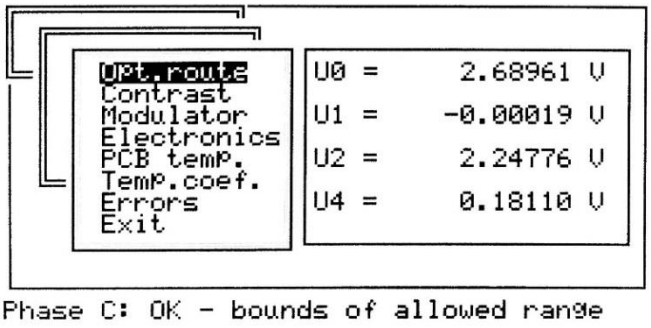


Figure 18 – Submenu "Diagnostics – Phase A – Opt. route"

Moving to the line below (Figure 19) allows the User to get real-time information about the percentage of the useful optical signal (contrast of the interferometer) used to calculate the current. After pressing the central button the User can see the acceptable limits of the parameters in normal operating mode.

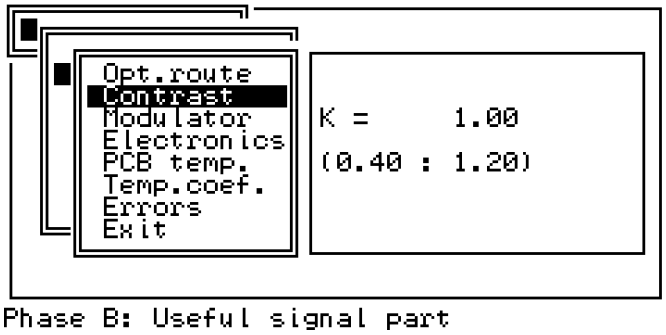


Figure 19 – Submenu "Diagnostics – Phase A – Contrast"

The "Modulator" submenu (Figure 20) contains real-time information about the status of the fiber-optical modulator of the interferometer (voltage modulation value, phase modulation value).

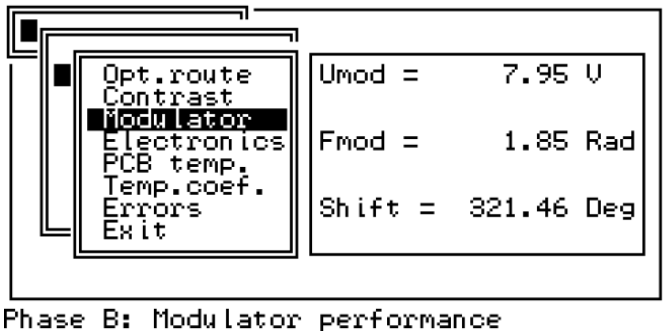


Figure 20 – Submenu "Diagnostics – Phase A – Modulator"

The information about the temperature inside the current transformer EPU is shown in the "PCB temperature" line (Figure 21).

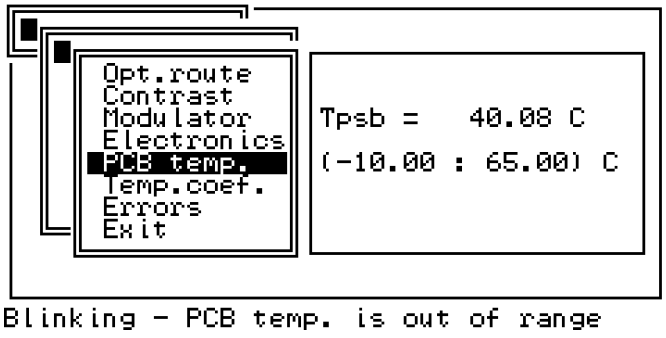


Figure 21 – Submenu "Diagnostics – Phase A – PCB temp."

The "Temp. coef." line allows the User to check the operability of the temperature correction of current measurements taking the temperature of the sensing element into account (Figure 22).

The temperature coefficient (TK) is not equal to the ambient temperature.

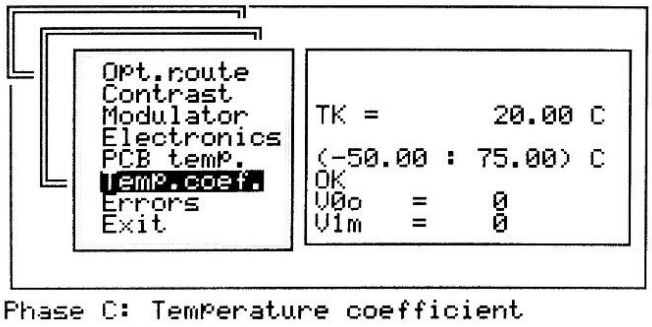


Figure 22 – Submenu "Diagnostics – Phase A – Temperature coefficient"

The "Errors" line (Figure 23) allows the User to localize the fault of EPU in case the red LED is lit up on the front panel. In case of a malfunction the word "ERR" appears in the line corresponding to the faulty EPU part.

Figure 23 – Submenu "Diagnostics – Phase A – Errors"

After entering the "Diagnostics" submenu in the main tree and selecting the "Light source" line (Figure 24) the User can see the details of the light emitter parameters: power, diode pumping current, diode pumping temperature with acceptable range limits required for its normal operation.

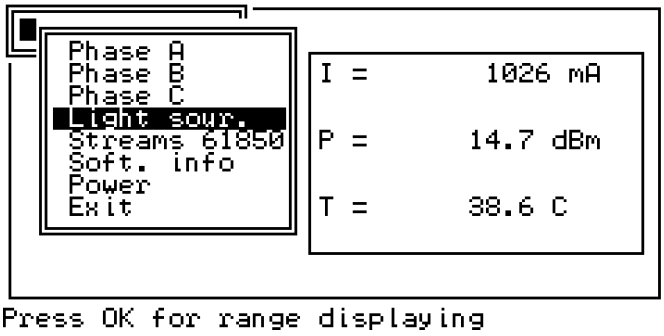


Figure 24 – Submenu "Diagnostics – Light source"

The "Streams 61850" line (Figure 25) allows the User to view the current settings of the digital streams of the current transformer EPU.

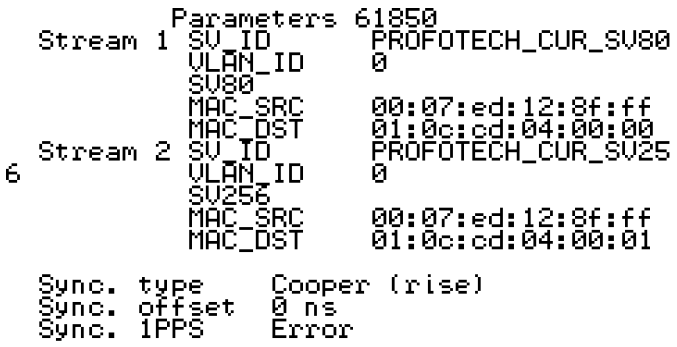


Figure 25 – Submenu "Diagnostics – Streams 61850"

The "Soft. info" line of the "Diagnostics" submenu contains the necessary information about the software used in the ECT EPU (Figure 26).

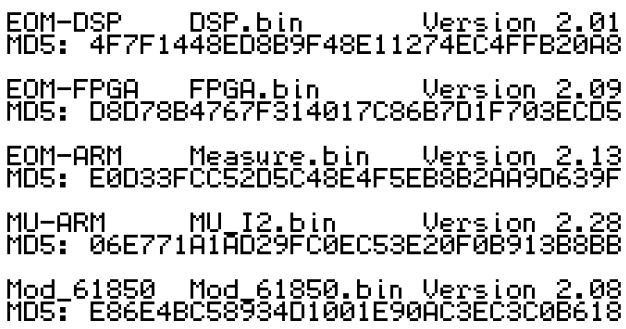


Figure 26 – Submenu "Diagnostics – Soft. info"

The "Power" line contains the information about the power supply module of ECT EPU (Figure 27).

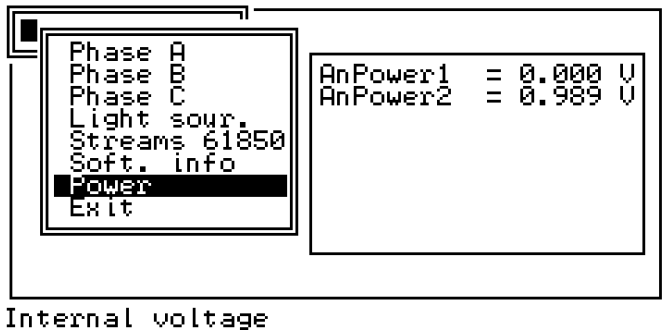


Figure 27 – Submenu "Diagnostics – Power"

2.2 EVT EPU menu

Monitoring of the EVT EPU status is carried out via the display on the front panel. Navigation through the menu is performed by five control buttons (Figure 28).

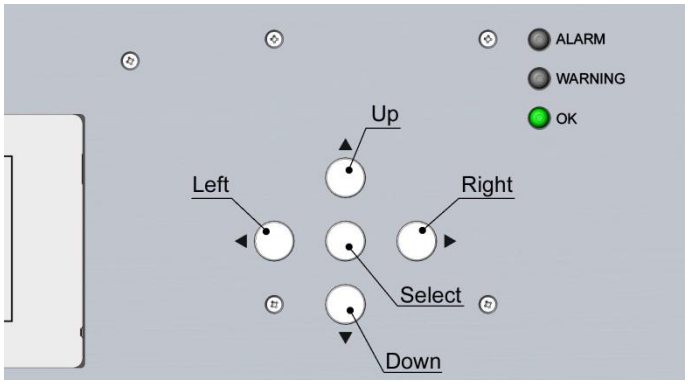


Figure 28 – Control buttons

By default, the display shows a picture similar to the one shown in Figure 29. The main menu is located on the left side of the screen, and on the right side there is a current value of measured voltage.

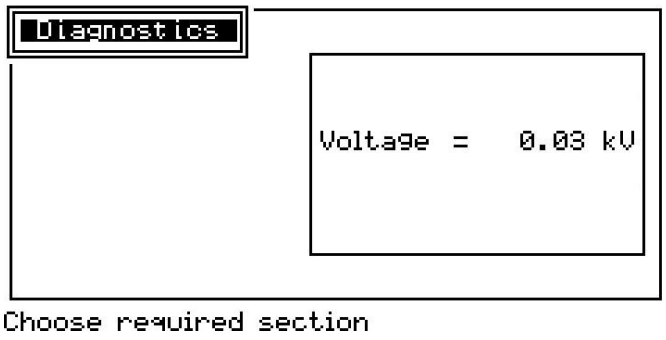


Figure 29 – The default menu view after the power up

The User can enter the submenus without interrupting the operation of the Device. The right part of the display keeps showing the actual phase voltage and frequency unless a new desired parameter is selected. If the User selects the "Diagnostics" submenu, the display screen shows a picture similar to the one shown in Figure 30.

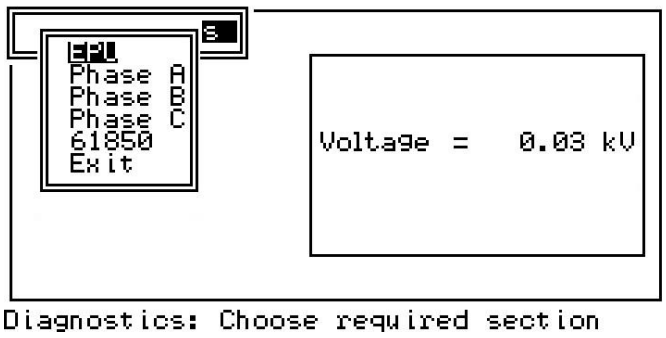


Figure 30 – "Diagnostics" submenu

In the submenu the status of operability of optoelectronic modules for each of the three phase channels of voltage measurement is monitored, as well as the status of

operability of the optical emitter. When the LED indicators on the front panel are turned on, this submenu allows the User to localize a specific fault without connecting an external PC. If any phase is selected in the "Diagnostics" submenu, the display shows a list of the main parameters that determine the operability of this measurement channel (Figure 31).

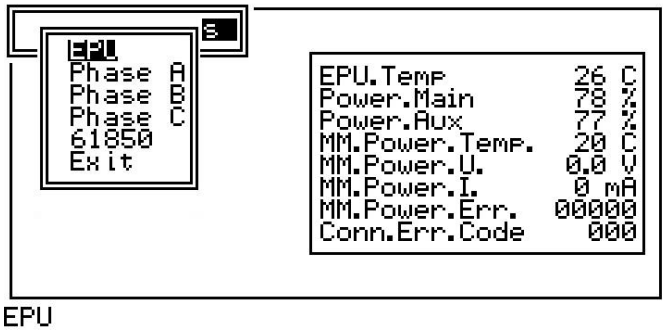


Figure 31 – Submenu "Diagnostics – EPU"

The parameters in other phases are monitored the same way.

The "Temp. int." line (Figure 32) allows the User to check the temperature inside the voltage electronic optical unit.

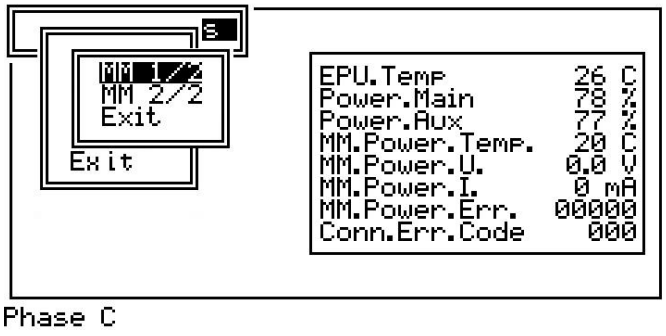


Figure 32 – Submenu "Diagnostics – Phase C"

The "MM 1/2" and "MM 2/2" submenus allow the User to control the parameters of measuring module.

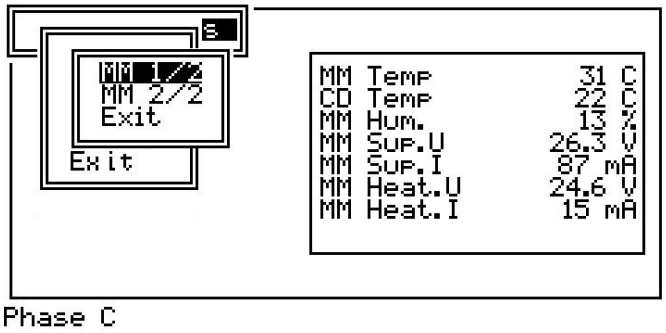


Figure 33 – Submenu "Diagnostics – Phase C – MM 1/2"

Figure 34 – Submenu "Diagnostics – Phase C – MM 2/2"

The "Parameters 61850" submenu (Figure 35) allows the User to view the current settings of the EVT EPU 61850 module.

Figure 35 – Submenu "Diagnostics – 61850"

The "Int. Power" submenu allows controlling the parameters of power supply of the EVT EPU modules.

3 Routine maintenance

3.1 General

Periodic inspection and routine maintenance are recommended to keep the CNCIT in good running order.

During maintenance it is necessary to follow the requirements of this manual and relevant safety regulations.

Frequency of maintenance is specified by the regulations of the operating organization (at least once per year).

CNCIT maintenance includes maintenance of HV columns and electronic units.

Attention! High voltage! Before performing maintenance procedures, the CNCIT must be de-energized and grounded.

3.2 Device maintenance procedure

3.2.1 Maintenance of high-voltage columns

Maintenance of high-voltage columns includes:

- ambient conditions monitoring;
- visual inspection (including application of thermal imagers) with check of grounding condition;
- periodic inspection of support structures and bolt connections' condition;
- check of bus system connection reliability;
- inspection of fiber-optic cable in free access areas;
- evaluation of paint-and-lacquer and metallic coating condition.

If any defects of conductive parts or insulation are detected the transformer must be decommissioned.

3.2.1.1 Inspection of HV column insulator

This inspection is carried out to detect damages of insulators and to determine their level of pollution.

It is also recommended to perform this procedure without de-energization, at night and under adverse conditions (dew, rain, high air humidity) when nature of luminance can help to detect seats of destruction of the protective coating by surface partial discharges. With that special devices can be used including thermal imagers.

List of the possible insulator damages during operation is shown in Table 1.

Table 1 – Possible insulator damages and their correction methods

Damage description, external damages	Possible cause	Correction method
Presence of erosion craters with depth over 3 mm	Exceedance of the permissible level of pollution	Decommissioning and replacement of HV column
Skew, upper flange slipping off the glass fiber rod	Exceedance of the permissible bending and torsion loads	Decommissioning and replacement of HV column
Rib rupture, rod stripping	Insulator mechanical damage	Decommissioning and replacement of HV column
Flange fusion, burn-off of coating part, rod stripping at flanges	Long term power arc	Decommissioning and replacement of HV column

3.2.1.2 HV column cleaning

In case of insulators' operation in the areas with high level of pollution their cleaning may be required during operation.

Depending on the type and location of the insulator it can be cleaned by two methods: manually or by washing with water jet.

Washing with water jet can be carried out in de-energized state using mobile or stationary washing installations. Also, it is possible to wash with energized conductive parts provided that occupational safety requirements of the respective organization are observed.

When washing do not aim water jet at the SE housing!

Manual cleaning of insulators must be carried out only in de-energized state with soap water solution using cloth or soft brush. After such cleaning the insulators shall be washed with clean water.

Oil can be removed with alcohol-based cleaning agents and solvents with further washing with clean water.

3.2.2 Maintenance of electronic units

Prior to execution of any maintenance procedures the personnel carrying out the maintenance should check the ambient temperature and parameters of the Device power supply. If these parameters do not comply with the requirements of the Device Technical Passport, make the respective record to the official who is responsible for maintenance of the temperature conditions in the places of Device's installation and make the respective records in the defects and malfunctions log;

Maintenance of electronic units consists in periodic inspection of self-diagnostics data using device state LED indicators on the front panel and emergency LEDs on the electronic modules (rear panel). To locate the failure, it is necessary to open the "Errors" submenu in the "Diagnostics" menu.

In case of pollution of the electronic units, dust and dirt must be removed with an antistatic vacuum cleaner. The vacuum cleaner must be equipped with antistatic tip or brush.

4 Storage

Before being put into service all components of CNCIT should be stored in the original packaging. Reels with the fiber optic cable should be covered with wooden lagging.

Avoid storage of the CNCIT in these places:

- Places that are exposed to direct sunlight
- Dusty places
- Damp places where condensation may occur on the Device surface
- Places where the CNCIT may be oxidized or corroded by active gases
- Places where the CNCIT may be exposed to strong vibration and shock
- Places where the CNCIT might topple over
- Places with temperatures and relative humidity in the following ranges:

  Temperature: lower than -10°C or higher than 50°C

  Humidity: 90% or more

If the CNCIT is not to be used for a long period of time, is recommended to store it in a place that meets the ambient conditions suggested above, plus the following conditions:

- Temperature: 5 to 40°C
- Humidity: 40 to 80%
- Little temperature and humidity fluctuations within one day

If the CNCIT EPUs was stored at negative temperatures, prior to putting into operation it is necessary to unpack it and put into a warm dry place at least for 24 hours.

5 Transportation

All parts of CNCIT must be transported only in the original packaging. Prior to transportation it is necessary to check packaging integrity. During handling and transportation operations it is necessary to observe the requirements of the shipping labels applied on the packaging. The packaging must be located and secured in a proper way to prevent them from displacement and collisions.

The packaging may be equipped with Shock Detector (Figure 36). Detector activation indicates violation of transportation or handling conditions.

In case of Shock Detector activation immediately inform the Customer Support of the Manufacturer!

a) b)

Figure 36 – Shock detector before (a) and after (b) activation

6 Recycling and disposal

6.1 Packaging

The product’s packaging is made of wood and plywood. All materials used in the packaging can be recycled. The Manufacturer does not take back used packages.

6.2 EPU and HV columns

After the end-of-life main parts of the Device can be recycled.

Recycle of metal parts and most of other materials should be conducted according to local regulations.

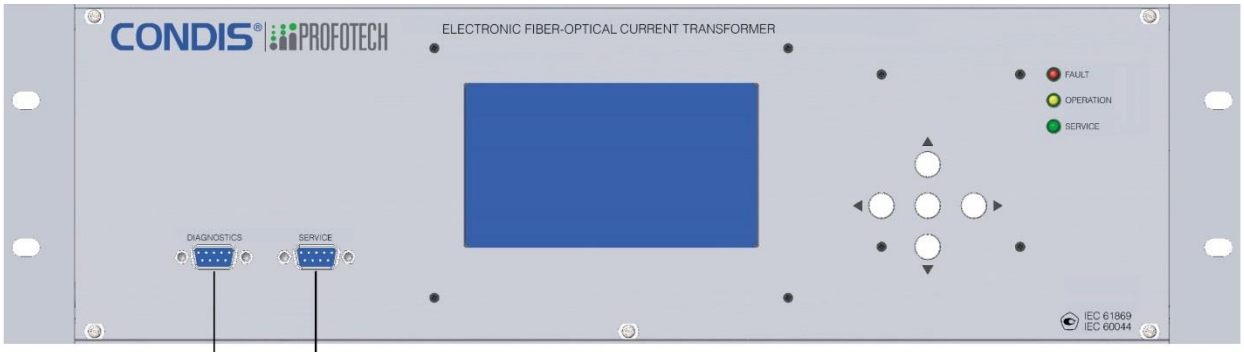
Printed boards should be specially utilized according to IEC 62635 guidelines.

List of Abbreviations

CNCIT	–	combined non-conventional instrument transformer
ECT EPU	–	current transformer electronic processing unit
EVT EPU	–	voltage transformer electronic processing unit
EOM	–	electronic optical module
EPU	–	electronic processing unit
HV	–	high voltage
SE	–	sensing element
SPTA	–	spare parts, tools and accessories
SV	–	sample values

Annex A. ECT EPU external connections diagram

Front view

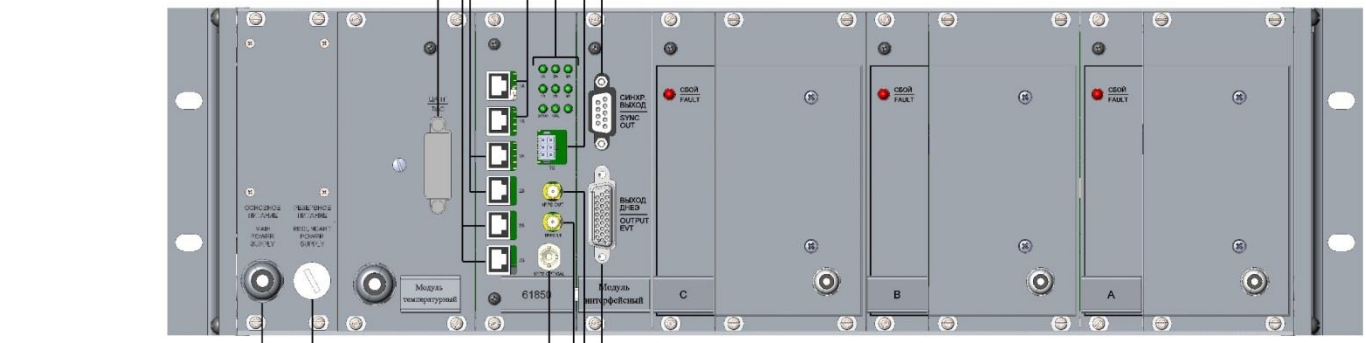


Port name: **Diagnostics input**
Connector type: **9-Pin D-Type Female**
Interface: **RS-422**

Port name: **Service input***
Connector type: **9-Pin D-Type Female**
Interface: **RS-422**

* sealed by the manufacturer

Rear view



Port name: **2A, 2B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-9-2, PTP**

Port name: **1A, 1B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-9-2, PTP**

Port name: **3A, 3B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-8-1, PTP**

LED status indicators

TC output

Port name: **DAC-C connection output**
Connector type: **26-Pin D-Type M**
Communication protocol: **Proprietary protocol**

Port name: **Synchronization output**
Connector type: **9-Pin D-Type F**
Communication protocol: **Proprietary protocol**

Name: **Power supply input**
Input voltage: **220 V AC***
Type of adapter: **Type C***

Port name: **ECVD connection output**
Connector type: **26-Pin D-Type F**
Communication protocol: **Proprietary protocol**

Name: **Redundancy power supply input**
Input voltage: **220 V AC***
Type of adapter: **Type C***

Port name: **1PPS output**
Connector type: **SMA-F**
Communication protocol: **TTL (3,3 V)**

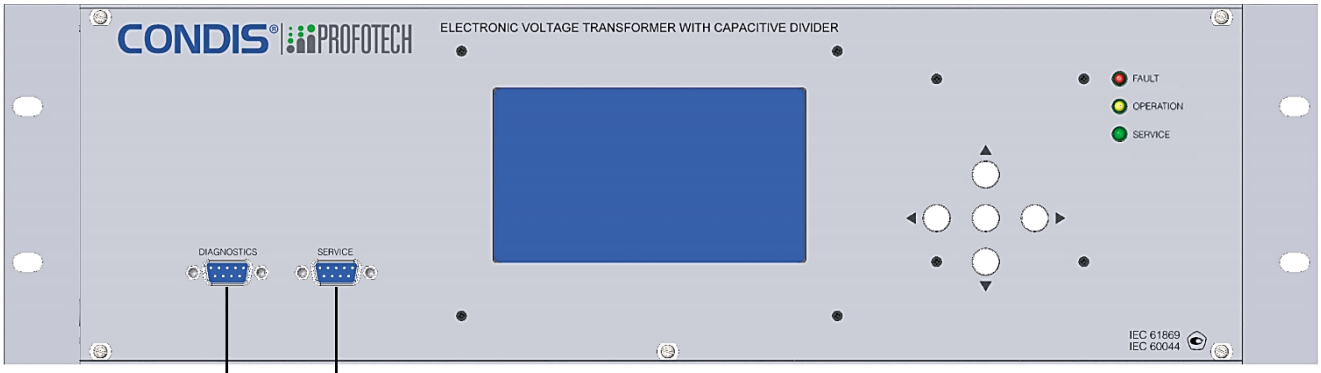
Port name: **1PPS optical input**
Connector type: **ST**
Communication protocol: **1PPS, MM**

Port name: **1PPS input**
Connector type: **SMA-F**
Communication protocol: **TTL (3,3 V)**

* depends on the customer's needs

Annex B. EVT EPU external connections diagram

Front view

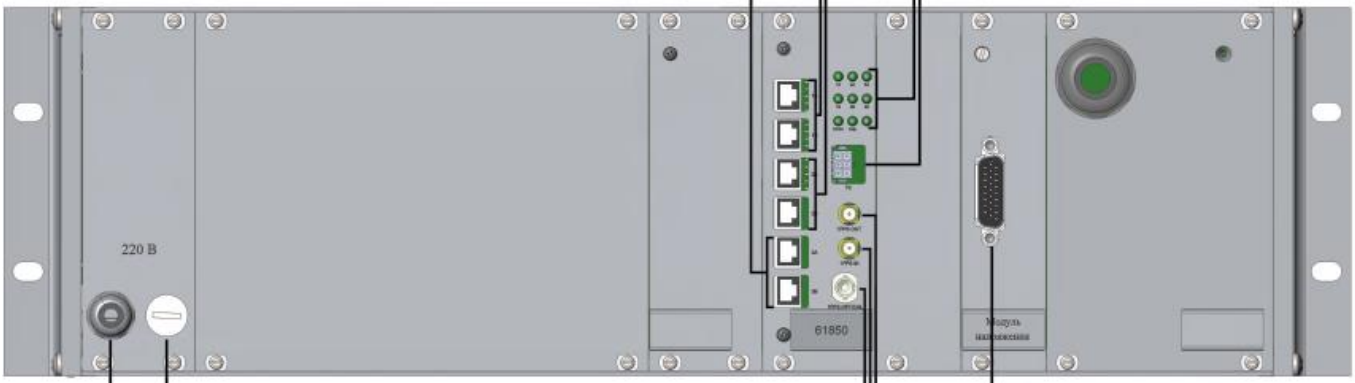


Port name: **Diagnostics input**
Connector type: **9-Pin D-Type Female**
Interface: **RS-422**

Port name: **Service input***
Connector type: **9-Pin D-Type Female**
Interface: **RS-422**

* sealed by the manufacturer

Rear view



Port name: **1A, 1B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-9-2, PTP**

Port name: **2A, 2B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-9-2, PTP**

Port name: **3A, 3B**
Connector type: **MTRJF-100 Mbit MM**
Communication protocol: **IEC 61850-8-1, PTP**

LED status indicators
TC output

Name: **Redundancy power supply input**
Input voltage: **220 V AC***
Type of adapter: **Type C***

Name: **Power supply input**
Input voltage: **220 V AC***
Type of adapter: **Type C***

Port name: **DAC-V connection output**
Connector type: **26-Pin D-Type F**
Communication protocol: **Proprietary protocol**

Port name: **1PPS output**
Connector type: **SMA-F**
Communication protocol: **TTL (3,3 V)**

Port name: **1PPS input**
Connector type: **SMA-F**
Communication protocol: **TTL (3,3 V)**

Port name: **1PPS optical input**
Connector type: **ST**
Communication protocol: **1PPS, MM**

* depends on the customer's needs